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Remarks and Arguments

Reconsideration is respectfully requested.

Claims 1-13 are pending in the present application before this amendment. By the present amendment claims 1, 7, 10, and 13 have been <u>amended</u>. No new matter has been added.

In the office action (page 2), claims 1-3, 6, 7, 10, and 13 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,485,613 (Engelstad) in view of U.S. Patent No. 5,640,529 (Hasbun). The "et al." is deleted in a reference.

The applicants respectfully disagree.

The present invention relates to a garbage collection method that balances the load of garbage collection by distributing and performing the garbage collection in a plurality of communication cycles. By dividing the load of the garbage collection, the presently claimed invention reduces the possibility of a response delay or a timeout in the command/response communication environment of a computing device **having a non-volatile memory** (e.g., a smart card).

In a medium used for user-interactive communication, such as a smart card, only one application program is active when the user-interactive communication is performed, and thus, a typical smart card cannot have a separate process for managing garbage collection. As such, a predetermined process for garbage collection is performed **only during its activated period of time.**

Even more importantly, in a smart card it is difficult to perform both the mark and sweep phases of garbage collection. **Particularly, it takes a lot of time to write in the**

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writable non-volatile memory (e.g., an erasable programmable read-only memory

(EEPROM) of a smart card (specfication page 2, lines 9-18).

Smart card-based computing systems are different from conventional computing

systems because objects can reside in writeable non-volatile memory (e.g., EEPROM

or Flash memory). A typical garbage collection technique is not suitable for EEPROM

or flash memory, because, for example, individual memory elements in EEPROM and

flash memory can only be written to a limited number of times; and, as stated above, it

takes <u>a lot of time</u> to write to the writeable non-volatile memory. As such, existing

garbage collection techniques, which operate by frequently marking objects in memory,

are not suitable for the writeable non-volatile memory, as the frequent marking

degrades system performance.

The present invention provides a method for garbage collection that is suitable

for a computing system that includes a writeable non-volatile memory (e.g., the present

invention is suitable even for smart cards). The reason for this is the present invention

provides **a first list of objects** *instead* of marking objects in memory. In addition, the

present invention stores and updates this first list of objects, so that garbage collection

can be carried out over a plurality of communication cycles. Thus, the first list of objects

which is updated/stored allows the present invention to divide the load of the garbage

collection resulting in a reduction of the possibility of a response delay or a timeout in,

for example, a command/response communication environment

The applicants addressed the –first list of objects– in the previous office action.

However, it appears as though the examiner again uses a reference in which objects

are **marked** in memory, and which does not create --a first list of objects to be deleted

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from memory— which is updated/stored. In the office action (page 2), the examiner

states "the first list corresponds to unmarked objects in the condemned region [of

Engelstad], since the objects being unmarked means they are to be deleted from

memory." The applicants again respectfully disagree. A list of objects to be deleted

would not by anyone skilled in the art be interpreted as objects marked in memory.

However, to end any further argument on the subject, the applicants have amended

claim 1 to clarify these features of the present invention.

The present invention now recites:

—making a first list of objects to be deleted from **the writeable non-volatile
memory**—

Thus, the present invention makes clear that the objects are stored in a writeable

non-volatile memory, and as stated above, the presently claimed invention provides a

method that is suitable for use in writeable non-volatile memory, since a list of objects to

be deleted is utilized rather than a method of marking objects in memory.

Also, the present invention recites:

—wherein the updated first list stored in the memory is an address list including
addresses of objects to be deleted from the non-volatile memory, and deletion of
the objects is performed using the address list—

Support for this amendment can be found at least in the specification page 9,

lines 1-6. This further makes clear that the first list of the present invention is **not** simply

objects marked in memory, and is instead an actual list of addresses of the objects to

be deleted. In the present invention of claim 1, the first list is updated —to list those

undeleted objects of the first list which remain after the lapse of the calculated residual

time— and the list is —stor[ed] in memory—, which allows garbage collection to be carried

out over a plurality of communication cycles.

In contradistinction, Engelstad discloses that bits which are marked are not deleted during garbage collection. That is, in Engelstad, "all objects within the condemned region that are **not marked** as referenced are guaranteed to be garbage" (Engelstad col 27, lines 9-11). Thus, in Engelstad, the objects are <u>marked</u> and there is **no** list of objects. This is further shown in FIGs. 6-16 of Engelstad, in which the objects themselves (or their corresponding headers) are marked, thus requiring frequent writes to the memory in which these objects are stored.

As such, Engelstad marks objects to be stored in memory so that they can be deleted, whereas the presently claimed invention makes a first list of objects which is stored in the memory, and the —first list stored in the memory is an **address list** including addresses of objects to be deleted from the **non-volatile memory**, and deletion of the objects is performed using the **address list**—. Thus Engelstad requires frequent writes to memory, which would degrade system performance in a computing system having objects stored in a writeable non-volatile memory, whereas the present invention provides a first **list** of objects, which minimizes writes to the writeable non-volatile memory, and additionally allows for the garbage collection to be divided among a plurality of communication cycles.

Thus, as described above, Engelstad fails to teach the present invention of claim 1. Hasbun also fails to teach the above described aspects of the present invention. As described in the previous amendment (page 14), in Hasbun there is no list of objects to be deleted from memory, and there is no updating and storing of the list.

Accordingly, the applicants respectfully submit that neither Engelstad nor Hasbun, whether considered individually or in combination, teaches the present invention of

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claim 1, which recites, inter alia —wherein the updated first list stored in memory is an address list including addresses of objects to be deleted form the non-volatile memory, and deletion of the objects is performed using the address list. Accordingly, and indication of allowable subject matter with respect to claim 1 is respectfully requested.

As to **claim 6**, the examiner states "the garbage collection process will move on from step 8 in Column 13 Line 41 to step 1 in Column 13 Line 33, which is the beginning of making a second list with a new comdemned region". The applicants once again respectfully submit that in Engelstad no list of objects to be deleted is made is made, and objects are instead marked. Therefore, Engelstad does not teach this element of the present invention.

In any event, claim 6 depends from claim 1 and should be allowable for at least the same reasons.

As to **claim 7**, the applicants respectfully disagree with the examiner's allegations with regards to this claim. In the present invention, FIG. 3G shows an example of garbage collection 1-2 362 occuring before the external command is processed in a communication cycle. To clarify this aspect, the applicants have amended claim 6 to recites that the deletion occurs —**during the communication cycle**—. Thus, claim 6 makes clear that in this embodiment, deletion occurs during the communication cycle, whereas in Engelstad there is simply repetition of the same process, and the processing box 400 **always occurs** prior to the real-time garbage collection 402.

In any event, claim 7 depends from claim 1, and should be allowable for at least the same reasons.

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As to **claims 2-3 and 7**, the applicants respectfully submit that these claims are

allowable at least since they depend from claim 1, which is now considered to be in

condition for allowance for the reasons above.

As to **claim 10**, this apparatus claim has been amended for clarification in a

manner similar to that of claim 1. Therefore the applicants respectfully resubmit that

claim 10 is allowable for reasons similar to those stated above for claim 1. As such, the

applicant respectfully submit that neither Engelstad nor Hasbun, whether considered

individually or in combination, teaches or suggests the present invention of claim 10,

and an indication of allowable subject matter with respect to claim 10 is respectfully

requested.

As to **claim 13**, this claim contains the same limitation as that of claim 1 and is

recorded on a computer readable program. Therefore, the applicants respectfully

resubmit the arguments made for claim 1. Accordingly, neither Engelstad nor Hasbun,

whether considered individually or in combination, teaches or suggests the present

invention of claim 13, and an indication of allowable subject matter with respect to claim

10 is respectfully requested.

In the office action (page 5), claims 4-6 stand rejected under 35 U.S.C. §103(a)

as being unpatentable over Engelstad in view of Hasbun and further in view of U.S.

Patent No. 5,355,483 (Serlet).

As to **claim 4**, the examiner states

"Serlet teaches a way of listing object references in a memory such that all new
objects in memory (thus including ones that have not been deleted before) are
added to a list of ones to be marked for garbage collection"

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The applicants respectfully disagree. Claim 4 specifically recites --adding to the

first list **any object <u>earmarked</u> for deletion** in a prior communication cycle but

remaining in the memory undeleted. Thus claim 4 specifically recites that the object

added to the list have been previously earmarked, but not deleted within the time period

of the previous communication cycle.

Serlet does **not** in any way teach this element of the presently claimed invention.

Serlet at most teaches creating a memory "snapshot" and providing the "snapshot" to

the garbage collection process. The add to free list is **newly constructed** each time

the snapshot is created. Thus, it cannot be said that the "free list" of Serlet in any way

includes objects that were **earmarked for deletion in a prior communication**, when

Serlet creates a new list upon receiving the snap shot. Serlet's list would not include

any object earmarked for deletion in a previous communication cycle, because Serlet's

garbage collection is not spread out over communication cycles, and instead is a

method for **asynchronous** garbage collection. And thus any object earmarked for

deliver is in fact deleted. A new list is created including new objects that are to be

deleted is created, and is thus not an **updated** list. At least for this reason the

applicants respectfully submit that claim 4 is in condition for allowance over the cited

prior art references.

In any event, Claim 4 depends from claim 1 and should be allowed for at least

the same reasons, since Serlet fails to make up for the deficiencies of the references

cited in the rejection of claim 1. In Serlet, the list is quite different from that of the

present invention of claim 1. For example, in Serlet, the list is not updated to list

undeleted objects so that they can be deleted in a subsequent communication cycle and

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the objects in Serlit are not included in a writable non-volatile memory.

As to **claims 5-6**, the applicants respectfully submit that these claims are allowable at least since they depend from claim 1, which is now considered to be in condition for allowance for the reasons above. Serlet also fails to make up for the deficiencies described for claim 6 above.

In the office action (page 7), claims 8, 9, 11, and 12 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Engelstad in view of Hasbun and further in view of U.S. Patent No. 5,740,395 (Wells).

Wells fails to make up for the deficiencies of the prior art described above, and therefore the applicants respectfully submit that these claims are allowable at least since they depend from claim 1 or 10, which are now considered to be in condition for allowance for the reasons above.

For the reasons set forth above, the applicants respectfully submit that claims 1-13 pending in this application are in condition for allowance over the cited references. Accordingly, the applicants respectfully request reconsideration and withdrawal of the outstanding rejections and earnestly solicit an indication of allowable subject matter.

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This amendment is considered to be responsive to all points raised in the office

action. Should the examiner have any remaining questions or concerns, the examiner is

encouraged to contact the undersigned attorney by telephone to expeditiously resolve

such concerns.

Respectfully submitted,

Dated: Sep. 19 , 2008

W. William Park, Reg. No. 55,523
Ladas & Parry
224 South Michigan Avenue
Chicago, Illinois 60604
(312) 427-1300

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